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Abstract

Plant turnover increases aggregate productivity when efficient producers are more likely to survive. Given high entry and exit rates and the potential importance of net entry in accounting for aggregate productivity, in this paper we examine the determinants of plant exits and then examine how exits and other forms of output reallocation contribute to aggregate productivity. Using a unique plant-level longitudinal dataset for Colombia for the period 1982-1998, we examine the role of productivity and demand as well as input costs in determining plant survival. Moreover, given the important market-oriented reforms in Colombia during the early 1990s, we explore whether and how plant survival changed in response to trade liberalization. Our data permit measurement of plant-level quantities and prices, which allow us to decompose productivity and demand shocks, and in turn to estimate the effects of these fundamentals on plant survival. We find that higher productivity, higher demand and lower input prices increase the probability of plant survival. We also find that trade liberalization increased plant exit, while other reforms decreased plant exit. Moreover, trade liberalization makes high demand more important in determining survival, possibly because non-exporting low demand plants were unlikely to be exposed to competition prior to trade opening. By contrast, other reforms increase the importance of physical efficiency in determining survival, possibly because improvements in financial intermediation and increased factor adjustments enable reallocation towards promising projects, making efficient plants more likely to remain in the market.

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1 Introduction

Market economies are continually restructuring in response to changing conditions. Evidence from longitudinal micro business databases for developed countries shows that a large fraction of measured productivity growth is explained by more productive entering and expanding businesses displacing less productive exiting and contracting businesses. While the role of efficient reallocation has been broadly studied for developed countries, it has received much less attention in the context of developing economies. Understanding the determinants of business exit and its contribution to productivity dynamics is of particular interest in the context of emerging economies, where the development and improvement of institutions and market structure play a key role in improving allocative efficiency.

In this paper, we focus on one of the key aspects of the connection between productivity growth and firm dynamics – namely the relationship between plant exit and the underlying efficiency, costs and demand factors. Studying these factors is of interest for any country, as such rich set of market fundamentals are rarely available, and empirical studies of plant survival have traditionally focused on composite measures of productivity and related proxies of these determinants of exit, such as size and age. The case of Colombia, moreover, is of particular interest because of the important trade, labor and financial sector reforms in this country in the early 1990s, which allow us to also explore the interactions between underlying market fundamentals and market-oriented reforms for plant exit. The issue arises since a key objective of these reforms was to make product and input markets more competitive, with the expected effect of triggering the exit of less profitable establishments.

Our novel analysis explicitly measures and separates out the role of physical productivity, costs and demand factors for plant exit. Our ability to separate out these factors is possible in part due to the availability of plant-level output and input prices in the Colombian Annual Manufacturing Survey, which is rare in longitudinal business data. The availability of plant-level prices is important in terms of improving productivity measures, and separating physical efficiency from demand shocks. Establishment output is frequently measured in the empirical literature as revenue deflated by a common industry-level output price index, and establishment materials inputs as materials expenditures divided by a common materials industry-level input price deflator. Therefore, within-industry price differences are embodied in traditional output, materials and productivity measures. If prices reflect idiosyncratic demand shifts rather than quality or efficiency differences, then high measured productivity businesses may not be particularly efficient and previous studies may have overstated the connection between productivity and plant survival. Conversely, traditional measures of plant-level productivity confound low productivity with high input price measures. Given that our data has plant-level prices for both inputs and output, we are able to separate out the effects of productivity, demand shocks and cost shocks on plant survival.

In exploring these issues, our paper makes a number of methodological innovations relative to much of the literature. First, as already noted, we separate productivity from demand shocks and cost shocks. Second, the rich measures available enable us to take a novel approach to the estimation of factor and demand elasticities. In particular, we estimate production functions using local downstream demand as well as plant-level input prices for materials and energy and local expenditures as instruments. This, in turn, allows us to measure demand elasticities in a novel fashion as well; we estimate demand elasticities using total factor productivity as an instrument in the demand equations. Third, given that we can decompose efficiency, cost and demand effects at the plant level, we estimate exit equations in terms of fundamentals. Therefore, we do not have to rely on endogenous proxies such as plant age or size, which are commonly used in this context when fundamentals are less directly observable.

We find that market fundamentals are important determinants of plant survival. Higher physical productivity, higher demand and lower input costs reduce the probability that plants exit. In addition, consistent with a story of greater competition after trade liberalization, we find that trade reforms increase the probability that plants exit. By contrast other reforms, including tax and financial reforms, increase plant survival. This is consistent with financial deregulation improving access to credit and relaxing plants' credit constraints and with tax reductions increasing plants' profits.

We find a general pattern that market fundamentals become more important in determining plant survival after the reform process. However, when we examine specific reform indicators, we find that various reforms interact with market fundamentals in different ways. For example, we find that trade reforms increase the role of demand shocks, while other reforms increase the role of physical efficiency in determining plant survival. These findings indicate that low demand plants are less likely to survive after trade liberalization, possibly because these were likely to be smaller non-exporting plants not exposed to foreign competition prior to the trade reform. By contrast other reforms, particularly financial liberalization, seem to increase the importance of physical efficiency in determining survival. This is possibly because improvements in financial intermediation enable identification of promising projects and credit allocation to efficient plants, allowing them to remain in the market. More generally, increased flexibility in input and output reallocation makes inefficient plants relatively more likely to shrink and exit.

Finally, we conduct decompositions of average industry productivity into the contribution of the average plant and the contribution of allocative efficiency using a decomposition developed by Olley and Pakes (1996). To gauge the contribution of entry and exit, we examine this decomposition for both balanced and unbalanced panels of plants. We find that productivity is lower and grows more slowly after the reforms when we use a balanced panel compared to when we rely on an unbalanced panel. By construction, the difference between the balanced and unbalanced panels reflects the contribution of entering and exiting businesses. The greater productivity levels and growth of productivity in the balanced panel is consistent with the view that plant exits and other forms of reallocation of activity contribute to aggregate productivity, especially after the market reforms.

The rest of the paper proceeds as follows. In Section 2, we describe the market reforms introduced in Colombia during the 1990s. In Section 3, we describe the data from the Annual Manufacturing Survey. In Section 4, we present results on the impact of market fundamentals and market reforms on exit probabilities. Section 5 presents productivity decompositions that get at the effect of output reallocation on aggregate productivity. We conclude in Section 6.

2 Structural Reforms in Colombia

In 1990, the administration of President Cesar Gaviria introduced a comprehensive reform package, which included measures to modernize the state and liberalize markets. Reforms during the 1990s occurred in the areas of trade, financial and labor markets, privatization and the tax system. While the most important reforms occurred in the early 1990s in the areas of trade, and financial and labor markets, the second half of the 1990s also experienced important changes in terms of privatization and tax reform. The fact that different reforms were introduced at various points thus helps us to identify separately the effects of various reforms.

Trade was largely liberalized in Colombia during the 1990s. The gradual decrease in tariffs initiated by the preceding Barco government was accelerated by Gaviria after June 1991. By the end of 1991, nominal protection reached 14.4% and effective protection 26.6%, down from 62.5% a year earlier, while 99.9% of items were moved to the free import regime.

Other reforms sought to reduce frictions in labor markets. Law 50 of December 1990 introduced severance payments savings accounts and reduced dismissal costs by between 60% and 80% (see, e.g., Kugler (1999, 2004)). In 1990, the government also tried to introduce changes in the social security system as part of the labor reform package, but Congress forced an independent process to reform the pension system. The opposition to the original social security reform was mainly due to the proposal to reduce employers' contributions. Later during his administration, Gaviria compromised with Congress by passing Law 100 in 1993, which allowed voluntary individual conversions from a pay-as-you-go system to a fully-funded system with accounts, but also increased employer and employee contributions up to 13.5% of salaries, of which 75% was paid by employers (see, e.g., Kugler and Kugler (2003)).

A number of measures contributed to reduce frictions in financial markets. In 1990, Law 45 eliminated interest rate ceilings, eliminated investment requirements in government securities, and reduced reserve requirements. At the same time, supervision was reinforced in line with the Basle Accords for capitalization requirements, which establish minimum capital requirements weighted by risk. In addition, Law 9 of 1991 eliminated exchange controls eliminating the monopoly of the central bank on foreign exchange transactions and reducing restrictions on capital flows. Finally, Resolution 49 of 1991 eliminated restrictions to foreign direct investment, which facilitated foreign entry into all sectors, but, in particular, induced entry of foreign banks increasing competition in the financial sector (see, e.g., Kugler (2005)).

After Gaviria's term, in 1994 Ernesto Samper gained the election on a platform partly based on opposition to trade liberalization and other reforms.[1] While the new government did not dismantle the existing reforms at the time, it managed to stop the momentum for further liberalizing trade, and labor and financial markets. Instead, the Samper government made progress in the areas of privatization and tax reforms. Overall, the process of privatizations has been relatively limited in Colombia compared to the rest of Latin America; while cumulative privatizations represented over 10% of GDP in 1999 in several countries, in Colombia cumulative privatizations were only 5% of GDP. Although privatizations in Colombia started in 1991, the process speeded up during the Samper and Pastrana governments. However, the composition of privatization has been highly concentrated in Colombia, with about 80% of all privatization occurring in the energy sector and another 15% in the financial sector (Lora, 2001).

A number of changes in the tax system also occurred in the 1990s. For instance, in an effort to increase tax collection and the neutrality of the tax system, value added tax rates where increased, while income and corporate taxes were reduced. The value added tax grew in Colombia from 10% in 1985 to over 16% in 1999. At the same time, maximum tax rates on personal income were lowered to 30%, while the maximum tax rate on corporate income was reduced from 40% in 1985 to 35% in 1999. In spite of these changes, Colombia's tax system remains one of the most distorted when compared to those of other Latin American countries (Lora, 2001).

Given the complexity and differences in timing of the reforms, we construct a reform index to examine separately the effects of trade and other reforms on plant exits. Our index of reform is generated from the data on institutions collected by Lora (2001). The reform index, which varies yearly, measures the degree of market orientation in the areas of trade openness, labor regulation, financial system, privatization and taxation. Following Lora (2001), we generate indices of market reform that separate trade from other reforms, including privatizations as well as changes in financial and labor markets, and the tax system. We focus on trade reform as opposed to any other reform because the data do not offer enough variability to separately estimate the effects of different reforms at higher levels of disaggregation, and among all reforms the trade aspect is the one that has received most attention in Colombia as a key determinant of plant survival.

For a given area of reform (such as trade) Lora's methodology calculates an index based on relevant subcomponents, each evaluated in a 0-1 scale, where 0 (1) corresponds to the most (least) rigid institutions in Latin America over the period for

[1] Note that the Colombian electoral system at the time ruled out election for more than one term.

the corresponding subcomponent.[2] Since our focus here is on Colombia, we re-scale Lora indices so that each subcomponent is measured relative to the minimum and maximum level of reform in Colombia (rather than Latin America) within the period. Figure 1 presents our Trade Reform Index and Other Reform Index, which have an increasing trend over the period, with an important discrete increase at the beginning of the 1990s for trade reform. Overall, the reform indices suggest that the reform process was relatively smooth and successful in reducing distortions from product and factor markets. If the goal of enhancing efficient reallocation in the economy was achieved, its success should be reflected in different exit patterns of plants before and after the reforms.

3 Plant-level Data

In this section, we first provide a description of the data and, then, we explain the measurement of physical productivity and demand shocks.

3.1 Data Description

Our data come from the Colombian Annual Manufacturers Survey (AMS) for the years 1982 to 1998. The AMS is an unbalanced panel of Colombian plants with more than 10 employees, or sales above a certain limit (around US$35,000 in 1998).[3] The AMS includes information for each plant on: value of output and prices charged for each product manufactured; overall cost and prices paid for each material used in the production process; energy consumption in physical units and energy prices; production and non-production number of workers and payroll; and book values of equipment and structures.

Since we are interested in the effects of efficiency and demand on plant exits, we need to construct measures of productivity and demand shocks at the plant level. To this end, we first estimate total factor productivity (TFP) values for each plant using a

[2] The trade index has two subcomponents: average tariff, and tariff dispersion (higher average and dispersion interpreted as more rigid institutions). The "other reforms" index includes: reserve requirements faced by financial institutions; adherence of financial supervision to Bassle minimum criteria; a measure of interest rate controls; measures of different tax rates and efficiency in the collection of taxes; a measure of the extent of privatizations of state-owned enterprises; and the extent of layoff costs, restrictions on hiring temporary workers, requirements of higher pay for overtime work, and extent of contributions to social security. Greater financial restrictions, higher tax and labor costs, weaker supervision and collection institutions, and lower "stocks" of privatized firms, are all interpreted as capturing less developed market institutions.

[3] In the Appendix to Eslava et al.(2004), we describe in detail the methodology used to generate longitudinal linkages that allow following plants over time. As explained there, over the period of study the AMS underwent changes in the sampling and labeling of plants, which require very involved work to generate these linkages and to reduce spurious measurement of entry and exit of plants.

capital-labor-materials-energy (KLEM) production function and demand shock values for each plant using a standard demand function. Thus, we need to construct physical quantities and prices of output and inputs, capital stock series, and total labor hours to estimate production functions.

3.1.1 Plant-level Price Indices

With the rich information on prices collected in the AMS, we can construct plant-level price indices for output, materials, and energy. This represents an enormous advantage with respect to other sources of data, as the use of more aggregate price deflators is a common source of measurement error, due to plant-specific demand shocks. Prices of output and materials are constructed using Tornqvist indices. For a composite of products or materials i of each plant j at time t these Tornqvist indices are the weighted average of the growth in prices for all individual products or materials h generated by the plant. This weighted average is given by:

$$\Delta P_{ijt} = \sum_{h=1}^{H} \bar{s}_{hjt} \Delta \ln(P_{hjt}),$$

where $i = Y, M$, i.e., output or materials,

$$\Delta \ln(P_{hjt}) = \ln P_{hjt} - \ln P_{hjt-1},$$

and

$$\bar{s}_{hjt} = \frac{s_{hjt} + s_{hjt-1}}{2}$$

and P_{hjt} and P_{hjt-1} are the prices charged for product h, or paid for material h, by plant j at time t and $t-1$, and s_{ht} and s_{ht-1} are the shares of product h in plant j's total production, or the shares of material h in the total value of plant j's materials purchases, for years t and $t-1$.[4] The indices for the levels of output (or material) prices for each plant j are then constructed using the weighted average of the growth of prices and fixing 1982 as the base year:

$$\ln P_{jt} = \ln P_{ijt-1} + \Delta P_{ijt}$$

for $t > 1982$, where $P_{j1982} = 100$. The price levels are then simply obtained as $P_{ijt} = \exp^{\ln P_{ijt}}$.[5]

[4]The distribution of the weighted average of the growth of prices has large outliers, especially at the left side of the distribution. In particular, the distribution shows some negative growth rates of 100% and more. In a country like Colombia, with inflation around 20%, negative growth rates of these magnitudes seem implausible. For this reason, we trim the 1% tails at both ends of the distribution as well as any observation with a negative growth rate of prices of more than 50%.

[5]Given the recursive method used to construct the price indices and the fact that we do not have plant-level information for product and material prices for the years before plants enter the sample,

3.1.2 Capital Stock Series

Given prices for materials and output, the quantities of materials and output are constructed by dividing the cost of materials and value of output by the corresponding prices. Quantities of energy consumption are directly reported by the plant. In addition, we need capital stocks to estimate a KLEM production function.

The plant capital stock is constructed recursively on the basis of the expression:

$$K_{jt} = (1 - \delta) K_{jt-1} + \frac{I_{jt}}{D_t}$$

for all t such that $K_{jt-1} > 0$, where I_{jt} is gross investment, δ is the depreciation rate and D_t is a deflator for gross capital formation. Our capital stock series includes equipment, machinery, buildings and structures, while excluding vehicles and land. Our measure of D_t is the implicit deflator for capital formation from the input-output matrices for years 1982-1994, and from the output utilization matrices for later years. We use the depreciation rates calculated by Pombo (1999) at the 3-digit sectoral level, which range between 8.7% and 17.7% for machinery and between 2.4% and 9.8% for buildings.

Gross investment is generated from the information on fixed assets reported by each plant, using the expression:

$$I_{jt} = K_{jt}^{NF} - K_{jt}^{NI} - d_{jt} - \pi_{jt}^{A}$$

where $K_{jt}^{NF}$is the reported value of fixed assets by plant j at the end of year t, K_{jt}^{NI} is the reported value of fixed assets reported by plant j at the start of year t, d_{jt} is the depreciation reported by plant j at the end of year t, and π_{it}^{A} is the reported inflation adjustment to fixed asset value by plant j at the end of year t (only relevant since 1995, the first year in which plants were required by law to consider this component in their calculations of end-of-year fixed assets).

The capital stock series is initialized at the year the plant enters the sample, t_0. To obtain the initial value, we use the equation:

$$K_{it_0} = \frac{K_{it_0}^{NI}}{\frac{1}{2}(D_{t_0} + D_{t_0-1})},$$

where $K_{jt_0}^{NI}$ is the first reported nominal capital stock at the beginning of the year.

3.1.3 Labor Hours and Wages

Finally, we construct hours of employment. Since the AMS does not have data on worker hours, we construct a measure of total employment hours at time t for sector

we impute product and material prices for each plant with missing values by using the average prices in their sector, location, and year. When the information is not available by location, we impute the national average in the sector for that year.

$G(j)$, to which plant j belongs, as,

$$H_{jt} = \frac{earnings_{G(j)t}}{w_{G(j)t}},$$

where $w_{G(j)t}$ is a measure of sectoral wages at the 3-digit level, and $earnings_{G(j)t}$ is a measure of earnings per worker constructed from our data as

$$earnings_{G(j)t} = \frac{\sum_{j \in G} payroll_{jt}}{\sum_{j \in G} L_{jt}}$$

Our measure of $w_{G(j)t}$ is a weighted average of the sector-level wages for production and non-production workers, where the weights are the shares of each type of worker in total sector employment. The data on wages for each type of worker at the three-digit sector level are obtained from the Monthly Manufacturing Survey. Nominal wages are deflated using CPI.

3.1.4 Descriptive Statistics

Table 1 presents descriptive statistics of the quantity and price variables just described, for the pre- and post-reform periods. The table reports entry and exit rates of 9.8% and 8.7% during the pre-reform period, but a lower entry rate of 8.4% and a higher exit rate of 10.7% during the post-reform period.[6] The quantity variables are expressed in logs, while the prices are relative to a yearly producer price index to discount inflation. Output increased between the pre- and post-reform periods . Similarly, except for labor, input use increased between the pre- and post-reform periods. In particular, the table shows that capital, materials and energy use increased between the pre- and post-reform periods especially for incumbents and entrants. On the other hand, labor use decreased between the two periods for entering and exiting plants. Relative prices of output and materials prices declined between the pre- and post-reform periods for all plants.[7] Next, we use these variables to estimate the production function and inverse-demand equation.

[6]These entry and exit rates are lower than those reported for the U.S. and other OECD countries (Davis, Haltiwanger, and Schuh (1996)). Given that the Colombian economy is subject to greater rigidities, one may indeed expect lower entry and exit rates in the Colombian context (see, e.g., Tybout (2000) for a discussion of this issue).

[7]Caution needs to be used in interpreting the aggregate (mean) relative prices in this context since the relative price at the micro level is the log difference between the plant-level price and the log of the aggregate PPI. On an appropriately output weighted basis, the mean of this relative price measure should be close to zero in all periods (or one in levels) since the PPI is dominated by manufacturing industries. The larger difference with respect to PPI in the post-reform period reflects that the growth of manufacturing prices fell more rapidly than that of other prices in the economy, possibly due to the fact that external competition introduced by the reforms affected the manufacturing sector more than others.

3.2 Estimation of Productivity and Demand Shocks

We estimate total factor productivity with plant-level physical output data, using downstream demand to instrument inputs. In turn, we estimate demand shocks with plant-level price data, using TFP to instrument for output in the demand equation.

3.2.1 Productivity Shocks

We estimate total factor productivity for each establishment as the residual from a capital-labor-energy-materials (KLEM) production function:

$$Y_{jt} = K_{jt}^{\alpha}(L_{jt}H_{jt})^{\beta}E_{jt}^{\gamma}M_{jt}^{\phi}V_{jt},$$

where, Y_{jt} is output, K_{jt} is capital, L_{jt} is total employment, H_{jt} are hours, E_{jt} is energy consumption, M_{jt} are materials, and V_{jt} is a productivity shock.

Our total factor productivity measure is estimated as:

$$TFP_{jt} = \log Y_{jt} - \widehat{\alpha}\log K_{jt} - \widehat{\beta}(\log L_{jt} + \log H_{jt}) - \widehat{\gamma}\log E_{jt} - \widehat{\phi}\log M_{jt}. \quad (1)$$

where $\widehat{\alpha}$, $\widehat{\beta}$, $\widehat{\gamma}$, and $\widehat{\phi}$ are the estimated factor elasticities for capital, labor hours, energy, and materials. Since productivity shocks are likely to be correlated with inputs, OLS estimates of factor elasticities are likely to be biased. We thus present IV estimates, where we use demand-shift instruments which are correlated with input use but uncorrelated with productivity shocks. As described in Eslava et al. (2004), we construct Shea (1993) and Syverson (2004) type instruments by selecting industries whose output fluctuations are likely to function as approximately exogenous demand shocks for other industries. In addition, we use as instruments one- and two-period lags of the demand shifters just described, energy and materials prices, and regional government expenditures in the region where the plant is located.[8]

Table 2 reports results for the KLEM specification of the production function. Column (1) presents the OLS results from the estimation of the KLEM specification. The results imply elasticities for capital, labor, energy, and materials of about 0.08, 0.24, 0.12, and 0.59, respectively. However, as pointed out above, these elasticities are likely to be biased if productivity shocks are correlated with input use. Column (2) of Table 2 presents results using 2SLS estimation. Even if we think the instruments are weakly correlated with productivity shocks, large biases could be introduced when using IV estimation if the instruments are weakly correlated with the inputs.[9] To check whether inputs are highly and significantly correlated with the

[8] Sargan tests suggest these are valid instruments, including energy and materials prices which are unlikely to be affected by buyers' market power in the Colombian context. See Eslava et al. (2004) for further details on the instruments.

[9] We also considered other instruments, including longer lags and exponential terms. To select our baseline instruments, we tested for overidentifying restrictions using a variant of Basmann's (1960) test, where we estimate a regression of the production function residual on the instruments.

instruments, and given that we are considering instrument relevance with multiple endogenous regressors, we report in Column (3) the partial R^2 measures suggested by Shea (1997) for the first-stages, which capture the correlation between an endogenous regressor and the instruments after taking away the correlation between that particular regressor and all other endogenous regressors.[10] The partial R^2's for capital, employment hours, energy, and materials in the KLEM specification are 0.1276, 0.139, 0.231, and 0.324, respectively, and 0.2563 and 0.1324 for capital and employment in the value-added specification, showing that the relevant instruments for each input can explain a substantial fraction of the variation in the use of that input. The IV results in Column (2) of Table 2 also show larger elasticities for capital and energy, but smaller elasticities for labor hours and materials, when inputs are instrumented. The results, thus, indicate that productivity shocks during the period of study are positively correlated with employment hours and materials and negatively correlated with capital and energy.

Table 3 reports summary statistics for this and other measures of productivity. Our productivity measure, which follows the methodology just described, is denoted as "TFP" in the table. Notice, in particular, a high negative correlation of -0.6 of this measure with relative output prices, which reveals that high productivity plants are characterized by their ability to charge lower prices. Relative output prices in Table 3 are measured as the log difference between the plant's price index and a weighted average of the price indices of all plants for the current year, where physical output shares are used as weights.

The importance of using plant-level prices in the estimation of physical efficiency is evidenced by contrasting "TFP" with the measures of productivity that would result if output and materials where deflated with sector-level price indices. To calculate those alternative measures of productivity we construct internally-consistent sector prices for outputs and inputs, as a weighted average of the plant level prices, where the weights are physical output shares. We deflate plant output and/or materials using the corresponding sector level deflator, and recalculate productivity using these alternative measures of output and inputs and the same elasticities reported in Column (2) of Table 2.[11] The second row of Table (3) reports summary statistics of an

While lags of more than two periods and exponential terms of the demand shifters turn out to be significant in these regressions, the rest of our instruments are individually and jointly insignificant. We restrict our instrument list to include those instruments which are not jointly significant in this regression.

[10]The standard R^2 simply reports the square of the sample correlation coefficient between I_{jt} and $\hat{I}_{jt}$, where $I = K, L, E, M$ and $\hat{I}_{jt}$ are the predicted values of the inputs from a regression of I_{jt} on the instruments. The partial R^2 reports the square of the sample correlation coefficient between g_{jt} and $\widehat{g}_{jt}$, where g_{jt} are the residuals from an OLS regression of I_{jt} on all other inputs I_{1jt} and $\widehat{g}_{jt}$ are the residuals from an OLS regression of $\hat{I}_{jt}$ on the predicted values of all other inputs $\hat{I}_{1jt}$.

[11]Re-estimating the production function using these alternative measures of Y_{jt} and M_{jt} would require finding new instruments. The instruments we use for producing Table 2 rely on the assumption that a sector's downstream demand is uncorrelated with its productivity, an assumption that

alternative TFP measure that uses sector level deflators for both outputs and inputs (TFP1). Notice that the correlation of this measure with TFP, though high, is far from perfect. More interesting, the negative correlation between output prices and physical efficiency disappears when using this measure of productivity. This stems from the fact that, by ignoring price differentials across plants, this measure of TFP assigns a lower output to low-price plants than the appropriately deflated measure does. As we will see below, the ability to identify productivity differentials as movements along the demand schedule is key to decomposing the effects of demand and productivity shocks on a plant's survival probability. The next two alternatives we investigate the respective roles of mismeasuring output (TFP3) vs. inputs (TFP4) when using sector- rather than plant-level price deflators. Comparing the correlations of TFP with TFP3 and TFP4 shows that the most serious mismeasurement arises from measuring productivity using an output measure based on revenue deflated by a sectoral level output price deflator. By contrast, the high correlation between TFP and TFP4 shows that the mismeasurement of inputs using input expenditures deflated by a sectoral input price deflator yields a measure of productivity that is very highly correlated with the "true" measure.

3.2.2 Demand Shocks

While productivity is likely to be one of the crucial components of profitability, other components of profitability are also probably important determinants of plant exits. For example, even if plants are highly productive, they may be forced to exit the market if faced with large negative demand shocks. We capture the demand component of profitability by estimating establishment-level demand shocks as the residual of the following demand equation:

$$Y_{jt} = P_{jt}^{-\varepsilon} D_{jt},$$

where D_{jt} is a demand shock faced by firm j at time t and $-\varepsilon$ is the elasticity of demand.

Our demand shock measure is estimated as the residual from estimating this demand equation,

$$d_{jt} = \log \widehat{D_{jt}} = \log Y_{jt} + \widehat{\varepsilon} \log P_{jt}, \tag{2}$$

Using OLS to estimate the inverse-demand function is likely to generate an upwardly biased estimate of demand elasticities because demand shocks are positively correlated to both output and prices, so that $\widehat{\varepsilon}$ will be smaller in absolute value than the true ε. To eliminate the upward bias in our estimates of demand elasticities, we propose using TFP as an instrument for Y_{jt} since TFP is positively correlated with output (by construction) but unlikely to be correlated with demand shocks.

is unlikely to hold if plant prices are embedded in the productivity measure.

Table 4 reports OLS and IV results of estimating the demand equation.[12] OLS results presented in Column (1) suggest an elasticity of -0.9. Meanwhile, IV results in Column (2) which use TFP as an instrument for output, show much higher elasticity (in absolute value) of -2.23.[13] Finally, note that the last column in Table 4 reports an R^2 for the first stage of close to 0.4, indicating that our instrument explains a large fraction of price variability.

4 Effects of Market Fundamentals on Plant Exit

According to selection models of industry dynamics (e.g., Jovanovic (1982), Hopenhayn (1992), Ericson and Pakes (1995), and Melitz (2003)), producers should continue operations if the discounted value of future profits exceeds the opportunity cost of remaining in operation. The model we regard as most relevant is the one presented by Melitz (2003), where a producer with market power makes decisions on outputs, inputs, and output prices, given productivity shocks, demand shocks and input price shocks drawn by the producer from a joint distribution. Moreover, given fixed costs of operating each period, the producer makes a decision on whether or not to stay or exit at each point in time. In this model (as in other closely related models), the producer's exit decisions should be affected by the productivity, demand and input price shocks:

$$e_{jt} = \begin{cases} 1 \text{ if } PDV\left\{\pi(D_{jt}, P_{Ijt}, TFP_{jt})\right\} - C_{jt} < 0 \\ 0 \text{ if } PDV\left\{\pi(D_{jt}, P_{Ijt}, TFP_{jt})\right\} - C_{jt} > 0. \end{cases}$$

That is, plant j exits if the discounted value of net profits is below the fixed cost of operating and the firm exits, and continues in operation if the opposite holds. Profits, π, (and in turn the present discounted value, PDV) are a positive function of demand shocks and productivity and a decreasing function of input price shocks.

In practice, we estimate this relationship using a probit model where we specify the probability of exit between t and$t+1$ as a function of measures of market fundamentals in period$t-1$:

$$\Pr(e_{jst}) = \lambda_s + \delta_1 TFP_{jt-1} + \delta_2' P_{Ijt-1} + \delta_3 D_{jt-1} + u_{jt}, \quad (3)$$

[12] The sample size is larger in this table than in Table 2 because the estimations in that table require information on the instruments used for estimating the production function, while demand estimations only require information on output prices, physical output, and TFP estimates.

[13] The negative R-squares for the 2SLS are not surprising and should not be viewed as alarming. Price and the demand shocks are highly positively correlated. Using the simple demand equation, the variance of output will be equal to terms involving the variance of prices, the variance of demand shocks and a term that depends negatively on the covariance of output and demand shocks. Thus, the variance of demand shocks will exceed the variance of output and, hence, the negative R-squares.

where e_{jst} takes the value of 1 if the plant j in sector s exits between periods t and $t+1$; λ_s are sector effects; TFP_{jt} and D_{jt} are productivity and demand shocks; and P_{Ijt} is a vector including energy and materials prices, and u_{jt} is an i.i.d. error term. Table 5 reports summary statistics for the determinants of exit in the equation (3) (except for input prices which are presented in Table1). This table shows more volatility during the 1990s than the 1980s. Both the means and standard deviations of total factor productivity and demand shocks increased during the 1990s. At the same time, both the trade reform index as well as the index for other areas of reform increased during the 1990s compared to the 1980s. However, the indices suggest that trade seems to have been liberalized to a much greater extent than other areas.

Table 6 reports the results of alternative specifications for the probit models. Our core specification is reported in Column (3), but we consider some intermediate specifications to shed light on the sensitivity of the results. In all specifications, we control for 3-digit industry effects and aggregate GDP growth. Starting with the core specification, we find that higher physical efficiency, lower input prices and higher demand shocks are all economically and significantly important factors in determining exit. A rise in productivity by one standard deviation in the previous year is associated with a fall of 1.4% in the probability of exit in the current year. Increases in energy and materials prices of one standard deviation the previous year are associated with a rise of about 0.4 % and 1.1% in the probability of exit in the current year, respectively. We also find that an increase in plant-level demand by one standard deviation in the previous year is associated with a decline of 3.6% in the probability of closing down operations the current year. To appreciate the considerable magnitude of these effects note, from Table 1, that the exit rate is below 9% in the 1980s and below 11% in the 1990s.

To help us understand these results, we consider some intermediate specifications. In Column (1), we report the results of only including productivity and input price shocks on the probability of exiting. This specification is of interest because it provides perspective on the role of productivity and input prices if we neglected or ignored output price and demand variation. Column (1) shows that higher productivity and lower materials and energy prices lower the probability of exiting even if we omit both output price and demand variation. In particular, a rise in productivity of one standard deviation in the previous year is associated with a fall of about 1.3% in the probability of exit the current year. Increases in energy and materials prices the previous year are also associated with increases of about 0.4 and 0.7% points in the probability of exit, respectively. The role of productivity and input prices is thus mildly underestimated when demand shocks are excluded.

Column (2) adds output prices as an explanatory variable, which is of interest since output prices may reflect in part quality variation. In the extreme where all within industry price variation reflected quality differences, Column (2) would be the appropriate specification with the interpretation that we would have decomposed quality adjusted productivity into a physical efficiency and a product quality term.

Column (2) shows that higher productivity, lower input prices and higher output prices are associated with a lower probability of exit. It is interesting to compare the impact of productivity and input prices to both Columns (1) and (3). In comparison with Column (1), we find that physical productivity and input prices have a larger effect when controlling for output prices. This pattern is consistent with Table 3, which shows that productivity and output prices are negatively correlated. Then, a plant with low productivity and high input prices is also moving up along the demand schedule. Controlling for output prices, as Column (2) of Table 6 does, isolates the effect of productivity and input prices from movements along the demand schedule (and effectively also from shifts in this schedule), which go in the opposite direction. This explains the bias in the coefficients associated with productivity and costs in Column (1), as compared to Column (2).

It is also instructive to compare Columns (2) and (3). The productivity and input price effects in Column (3) are very similar to those in Column (2) and the demand shock variable (which by construction is orthogonal to both the productivity and the input price effects) has significant explanatory power. Thus, in comparing Columns (2) and (3), it is as though we have decomposed price effects into those effects that are correlated with movements along the demand schedule (through productivity and input price effects) and shifts of the demand schedule (through the demand shocks).

4.1 Effects of Market-oriented Reforms

We also explore whether the reforms introduced during the 1990s increased the importance of market fundamentals on plant survival. We extend our core specification by including interactions of productivity, input prices, and demand shocks with the reform indices. In particular, we extend equation (3), by including interactions of productivity, input prices, and output prices or demand shocks with the trade reform index, $Trade_t$, and an index that captures the effects of all other reforms, $Other_t$, during the 1990s in Colombia,

$$\begin{aligned} \Pr(e_{jst}) \;=\; & \lambda_s + \lambda_{TR} Trade_t + \lambda_{OR} Other_t + \delta_{10} TFP_{jt-1} \\ & + \delta_{1TR} TFP_{jt-1} \times Trade_t + \delta_{1OR} TFP_{jt-1} \times Other_t \\ & + \delta'_{20} P_{Ijt-1} + \delta'_{2TR} P_{Ijt-1} \times Trade_t + \delta'_{2OR} P_{Ijt-1} \times Other_t \\ & + \delta_{30} D_{jt-1} + \delta_{3TR} D_{jt-1} \times Trade_t + \delta_{3OR} D_{jt-1} \times Other_t + u_{jt}. \end{aligned} \tag{4}$$

Table 7 shows results which allow for interactions of market fundamentals with the reform indices. Column (1) shows the “main” effects (first row of equation (4)), Column (2) shows the interactions with the trade reforms and Column (3) includes the interactions with other reforms (which includes financial market and labor market reforms). We need to be cautious about interpreting the “main” effects by themselves because the value of the reform indices is always above zero within our sample. Nevertheless, pushed to their extreme, the "main" effects tell us the impact of market fundamentals if Colombia ever faced such poor institutions that all of the reform indices were equal to zero. Interestingly, Column (1) suggests that even at this extreme, plants with low productivity, low demand and high input costs are all more likely to exit. Column (1) also shows the effect of the reform indices considered individually. Independent of the state of market fundamentals, trade reforms increase the likelihood of exit while the other reforms decrease the likelihood of exit. Trade liberalization increases competition in the product market and this likely explains reduced plant survival following trade reforms. By contrast, other reforms, including the financial reform and tax reforms, reduced credit constraints for plants and this may explain greater plant survival, especially after financial deregulation.

Once we control for the depth of trade and other reforms, a rise in productivity of one standard deviation in the previous year is associated with a fall of about 1.3% and 1.5% points in the probability of exit during the pre- and post-reform periods, respectively.[14] An increase in lagged demand shocks of one standard in the previous year is associated with a decrease in the likelihood of exit by 4 percent in the pre-reform years and by 3.5 percent in the post-reform years. In terms of input costs, an increase in lagged materials prices of one standard deviation is associated with an increase in the probability of exit of about 0.4% and 1.6% points, pre- and post-reform respectively. Thus, overall there is a general pattern for market fundamentals to become more important after the market reforms, although this pattern does not hold for demand shocks.

The results of interactions with trade reforms in Column (2) suggest that demand shocks and cost shocks become relatively more important in determining survival as trade liberalization advances. This means that low demand or small plants are more likely to exit after trade opening. This is possibly because non-exporting small plants were the highly protected plants before trade liberalization, or because these plants are more likely to be credit constrained and thus more likely to suffer cash flow problems due to intensified competition.

By contrast, the results on the interactions with other reforms in Column (3) indicate increased importance of productivity in determining exits, but less importance of demand and cost shocks as these reforms advance. Greater importance of productivity after financial and other reforms can be explained by the fact that improved financial intermediation probably allows lenders to identify the most productive projects, thus allowing efficient plants to overcome credit constraints and survive more easily.

There are a few puzzles in the reported results in Table 7. It is less obvious why trade liberalization makes physical efficiency less important while other reforms make demand effects and input cost effects less important. Overall, the reforms taken

[14] To compute the implied effects in this paragraph, we use the standard deviations in Tables 1 and 5 pre- and post-reform for the market fundamentals and evaluate the market reform indices at their respective pre- and post-reform means.

together tend to make market fundamentals more important determinants of exit, so perhaps it is best to think of these in relative terms (e.g., trade reforms increase role of demand relative to other factors while other reforms increase role of physical efficiency relative to other factors). Alternatively, we may need a richer model of market selection with a richer characterization of the covariation and evolution of demand shocks, physical efficiency and input price shocks across businesses. Suppose, for example, that young businesses take time to build their market share and also face higher input prices given their relatively small size, even if they are highly productive. Then, financial market reforms may have made the role of demand and input prices less relevant as creditors might have been able to take these dynamics into account and focus to a greater extent on relative productivity which may be a better signal for long run profitability for young businesses. We leave the investigation of such richer models of market selection for future work

5 Plant Exits and Aggregate Productivity

In this section, we examine whether market selection and other forms of reallocation are associated with important productivity gains over the period. In particular, we quantify the contribution of allocative efficiency to aggregate productivity by using a cross-sectional decomposition methodology, first introduced by Olley and Pakes (1996). We quantify what fraction of aggregate productivity every year reflects average productivity and what part reflects the concentration of activity in more productive plants, by conducting the following decomposition of aggregate TFP:

$$TFP_t = \overline{TFP}_t + \sum_{j=1}^{J} \left(f_{jt} - \overline{f_t}\right)\left(TFP_{jt} - \overline{TFP}_t\right),$$

where TFP_t is the aggregate total factor productivity measure for a given 3-digit manufacturing sector in year t.[15] These aggregate measures correspond to weighted averages of our plant-level TFP measures, where the weights are market shares (calculated as described below). The first term of the decomposition, $\overline{TFP}_t$, is the average cross-sectional (unweighted) mean of total factor productivity across all plants in that sector in year t. TFP_{jt} is the total factor productivity measure of plant j at time t estimated as described in Section 3, f_{jt} is the share or fraction of plant $j's$ output out of sectoral output at the 3-digit level in year t, and $\overline{f}_t$ is the cross-sectional unweighted mean of f_{jt}. The second term in this decomposition measures whether

[15] This means that our focus here is on within sector reallocation rather than between sector reallocation, for sectors defined at the 3-digit level. For measurement and conceptual reasons, comparisons of TFP across sectors (in levels) are more problematic to interpret. Focusing on within sector allocation permits us to emphasize the degree to which market reforms have led to an improved allocation of activity across businesses due to higher competition.

production is disproportionately located at high-productivity plants and, as such, is a measure of allocative efficiency. Examining this decomposition over time allows us to learn whether the average unweighted productivity as well as allocative efficiency has changed, in particular in response to the market reforms.[16]

In order to evaluate the contribution of net entry, we consider yearly Olley-Pakes decompositions for three samples. The first sample contains all plants in our dataset, the second sample contains all plants that are continuously in existence for the entire sample period (the balanced sample), and the third sample contains all year-t businesses that are also present in year t-1 and t+1 (three-year continuers). The first sample provides perspective on the role of allocative efficiency for all plants. Since allocative efficiency can improve either through entry and exit or through reallocation of activity among continuing plants, the next two samples provide perspective about the role of net entry. In particular, while the balanced panel decomposition provides information about long lived continuously operating plants, the sample of three-year continuers contains some businesses that, while not in their first or last year, have entered recently or are about to exit.

Table 8 shows the results of this exercise. For each sample, the table reports the value of each term of the Olley-Pakes decomposition for the average three-digit sector. For the sample including all plants (Columns (1)-(3)), we see that aggregate industry productivity increased substantially over the sample period. For the average industry, productivity increased by 30 log points from 1982 to 1998. The decomposition shows that most of this increase, 21 out of the 30 points, is accounted for by an increase in allocative efficiency. Interestingly, the unweighted average component increased during the 1980s but actually fell during the 1990s. In contrast, the increase in allocative efficiency is concentrated in the 1990s, after the market reforms.

The balanced panel shows similar qualitative patterns with a large role for allocative efficiency especially in the 1990s. Thus, allocative efficiency improved even among long lived plants following market reforms. Interestingly, this sample actually shows a decline in the productivity of the average plant over the period. For the three-year continuers, we also observe the allocative efficiency term dominating the increase in productivity during the 1990s.

Comparing the dynamics of aggregate productivity across the three samples yields some insights on the role of net entry. For the period for which all samples are available (1983-97), we see that the whole sample and the three-year continuer sample exhibit an increase in aggregate productivity of about 25 log points, but the balanced panel exhibits only a 14 point increase in productivity. However, all three samples exhibit about a 15 point increase in allocative efficiency. Thus, the difference across the samples is largely in the unweighted productivity component. This provides evidence of a productivity enhancing effect of plant turnover, as the difference across

[16] An advantage of this cross-sectional method over methods that decompose changes in productivity over time, is that cross-sectional differences in productivity are more persistent and less dominated by measurement error or transitory shocks.

samples is, by construction, explained by the effect of entry and exit. While we have not focused here on the contribution of entry, part of the contribution of entry and exit is inherently related to whether productivity is an important determinant of exit. That is, exit will by construction raise the average unweighted productivity of the remaining plants for all plants and the three-year continuer samples, if and only if, it is the low productivity plants that exit. By contrast, this market selection contribution to the unweighted average is, by construction, not present in the balanced sample. Moreover, the fact that the growth of average productivity is similar in the whole sample and the sample of three-year continuers reveals that the contribution of entry and exit takes time and it does not simply refelect the contribution of turnover to productivity by very young plants (i.e., plants less than 3 years old).

The results of productivity decompositions, thus, reveal three related phenomena. First, the increase in average productivity in our whole sample is very much associated with an improvement in allocative efficiency. Second, the rise in aggregate productivity among incumbents throughout the sample period is fully accounted for by the expanding sectoral market share for relatively efficient plants at the expense of shrinking sectoral market share for relatively inefficient ones. Third, the contribution of entry and exit is both via the increased market shares of more productivity businesses but also through the impact of market selection on average unweighted productivity. Hence, these findings suggest that within sector reallocation and selection, at the 3-digit level, combined together account for aggregate productivity growth over the 1980s and 1990s in Colombian manufacturing.

6 Conclusion

Plant exit is an essential aspect of market selection. We have characterized the role of input costs, physical efficiency and demand in determining the likelihood of plant survival. We find that each of these three components plays an important role in explaining the probability of survival the following year.

We also examined the impact of market-oriented reforms on plant survival. While trade liberalization increases plant exit, financial and other reforms reduce the probability of exit. In addition, we find that trade liberalization increases the likelihood of exit for plants facing low demand and relatively high input prices. By contrast, financial and other reforms increase the role of efficiency and reduce the role of demand and input prices in determining plant survival. Trade liberalization squeezes out of operation plants with low profit margins. At the same time, improved factor market flexibility (capital and labor market deregulations) and private sector incentives (lower tax burdens and privatization) make plant physical efficiency relatively more important in accounting for plant survival relative to demand and input prices. This is probably due to more productive plants being able to expand at the expense of less productive ones.

We find that average productivity increased in the average 3-digit industry and that improvements in allocative efficiency are the primary driving force of this improvement. Our results suggest that plant entry and exit play a substantial role but that improved allocative efficiency amongst long-lived plants is also important. One issue for future research is to disentangle the respective contributions of improvement in allocative efficiency for continuing, entering and exiting plants. Such an investigation requires capturing the impact of market reforms on adjustment dynamics of continuing, entering and exiting businesses. A complicating factor in such an investigation is the recognition that all these dynamics are closely related – for example, an important component of the adjustment of continuing businesses might be the post-entry growth dynamics of young businesses as well as the exit of young businesses.

Our analysis of market reforms can be pushed in additional interesting directions as well. We use broad based measures of market reforms to examine the interaction of micro fundamentals and economy-wide reforms on market selection. We have not yet investigated how plants with observably different characteristics (e.g., young and small businesses) might have responded differentially to the market reforms. In a like manner, we have not yet investigated the extent to which market reforms themselves differ substantially across sectors or apply differently to businesses of observably different characteristics. We leave this investigation for future work.

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Figure 1: Lora Reform Indices

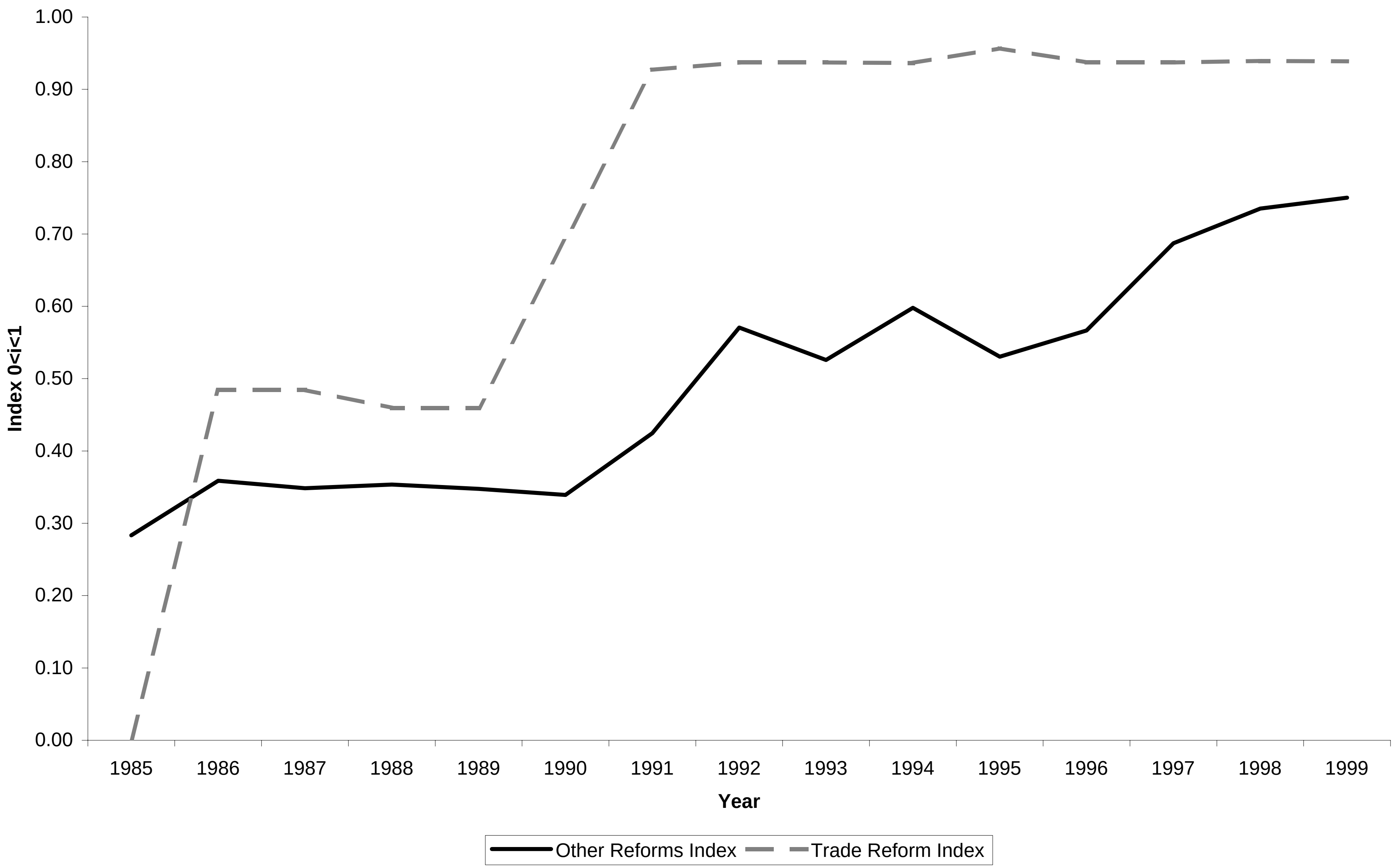

Table 1: Descriptive Statistics, Before and After Reforms

Variable	Pre-Reforms	Post-Reforms
Output	10.49	10.90
	(1.67)	(1.88)
Capital	8.21	8.75
	(2.05)	(2.18)
Labor	10.97	10.95
	(1.1)	(1.25)
Energy	11.30	11.55
	(1.88)	(1.99)
Materials	9.61	10.25
	(1.85)	(1.88)
Output Prices	-0.08	-0.15
	(0.44)	(0.74)
Energy Prices	0.25	0.55
	(0.50)	(0.43)
Material	0.02	-0.10
Prices	(0.35)	(0.57)
Entry Rate	0.0981	0.0843
Exit Rate	0.0873	0.1069
N	55,298	44,816

Notes: This table reports means and standard deviations of the log of quantities and of log price indices deviated from yearly log producer price indices. The entry and exit rates are the number of entrants divided by total plants and number of exiting plants divided by total number of plants. A plant that enters in t is defined as a plant present in t but not in t-1, while a plant that exits in t is one that is present in t but not in t+a. The pre-reform period includes the years 1982-90 and the post-reform period includes the years 1991-98.

Table 2: Production Function Equations

	OLS	2SLS	First Stage R^2
	(1)	(2)	(3)
Capital	0.0764 (0.0025)	0.3027 (0.0225)	0.128
Labor Hours	0.2393 (0.0037)	0.2125 (0.0313)	0.139
Energy	0.124 (0.0028)	0.1757 (0.0143)	0.231
Materials	0.5891 (0.0026)	0.2752 (0.0095)	0.324
R^2	0.8621	0.8107	-
N	48,114	48,114	-

Notes: Standard errors are reported in parentheses. The regressions in Columns (1) and (2) use physical output as the dependent variable, and capital, employment hours, energy, and materials as regressors, where all variables are in logs. For Column (2), the following variables are used to instrument the inputs: downstream demand instruments constructed as the demand for the intermediate output (calculated using the input-output matrix); one- and two-period lags of downstream demand; regional government expenditures, excluding government investment; and energy and material plant-level prices, deviated from the yearly PPI. The first partial R^2 reports the sample correlation coefficient between s_{jt} and $\hat{s}_{jt}$, where s_{jt} are the residuals from a regression of I_{jt} on all other inputs I_{1jt} and $\hat{s}_{jt}$ are the correlations between $\hat{I}_{jt}$ and the predicted values of all other inputs $\hat{I}_{1jt}$.

Table 3: Descriptive Statistics of Different TFP Measures

TFP Measure	Mean and SD	Correlation Coefficients Matrix				
		TFP	TFP2	TFP3	TFP4	RP1
TFP	1.0873 (0,765)	1 [86,251]	0.7048 [86,251]	0.6958 [86,251]	0.9885 [86,251]	-0.6310 [86,251]
TFP - Sector-level Output and Materials Prices (TFP2)	1.2123 (0.612)		1 [86,251]	0.9821 [86,251]	0.6973 [86,251]	-0.0081 [86,251]
TFP – Only Sector-level Output Prices (TFP3)	1.2172 (0.622)			1 [86,251]	0.6604 [86,251]	0.0220 [86,251]
TFP - Only Sector-level Materials Prices (TFP4)	1.0824 (0.772)				1 [86,251]	-0.6504 [86,251]
Output Prices relative to PPI (RP1)	-0.1201 (0.545)					1 [86,251]

This table reports means, standard deviations and correlation coefficients for different measures of TFP and for the plant-level output prices. Al figures are simple means of three-digit sector statistics. Numbers of observations for the calculation of correlation coefficients are reported in square parentheses. All measures of TFP are calculated using the factor elasticities reported in column (2) of Table 2. Alternative measures of TFP use output and materials deflated with either the plant-level price index or an internally consistent sector-level price index. The latter is calculated at the three-digit level as the geometric mean of plant tlevel indices, using output shares as weights.Relative output prices are constructed as the log difference between the plant's price index and an aggregate log price index. The latter is the Producer Price Index in RP1, and the weighted mean of plant-level prices (where the weights are physical output shares) for RP2.

Table 4: Demand Estimation

	OLS	2SLS	First Stage R^2
Regressor	(1)	(2)	(3)
Relative price	-0.9048	-2.2295	
	(0.0865)	(0.1907)	0.4299
R^2	0.1048	0.1897	-
N	100,114	86,251	-

Notes: Standard Errors are in parentheses. The dependent variable is physical output, and the regressor is the log difference between plant-level price and the yearly PPI. Both the estimation constant and demand elasticities are allowed to vary by three-digit sector; the figures reported are simple means of three-digit sector statistics, except for N, which is the toal number of observations including all sectors. The two-stage least squares regression instruments price with the 2SLS TFP measure estimated using Column (2) in Table 2. The first-stage R-squared reports the square of the correlation between Y_{jt} and $\hat{Y}_{jt}$, where $\hat{Y}_{jt}$ is the predicted value of output from a regression of Y_{jt} on the instruments.

Table 5: Descriptive Statistics of Determinants of Survival, Before and After Reforms

Variable	Pre-Reforms	Post-Reforms
TFP	1.1014	1.1414
	(0.6754)	(0.8612)
Demand	10.4966	10.7824
	(1.9119)	(2.1303)
Trade Reform	0.4362	0.9384
	(0.2046)	(0.0088)
Other Reforms	0.3391	0.5403
	(0.0247)	(0.0642)
N	55,298	44,816

Notes: This table reports means and standard deviations. The TFP measured is obtained using the factor elasticities estimated in Column (2) of Table 2, and the measure of Demand Shocks is obtained using the sector-level demand elasticities summarized in Column (2) of Table 4. The Trade Reform Index is the Lora Trade Reform Index, where each of its sub-components has been re-scaled to be 0 in the year of less liberalization and 1 in the year of most liberalization. The Index of Other Reforms is constructed in a similar fashion using all components of the Lora Overall Reform Index, except those included in the Trade Index.

Table 6: Determinants of Exit Probability

	(1)	(2)	(3)
Lagged Productivity	-0.0167	-0.0298	-0.0179
	(0.0046)	(0.009)	(0.0077)
Lagged Energy Prices	0.0078	0.0087	0.0085
	(0.0022)	(0.0026)	(0.0041)
Lagged Materials Prices	0.0155	0.0236	0.0238
	(0.0044)	(0.0072)	(0.0103)
Lagged Output Prices	-	-0.029	-
		(0.0088)	
Lagged Demand Shock	-	-	-0.018
			(0.0078)
Sector effects	YES	YES	YES
GDP growth	YES	YES	YES
Likelihood Ratio	642.2 (35 df)	751 (36 df)	1,516.6 (36 df)
N	57,515	57,515	57,515

Notes: Standard errors in parentheses. This table reports marginal effects from a Probit estimation of the probability of exit, where exit is 1 for plant i in year t if the plant produced in year t but not in year t+1. All specifications include sector effect at the three-digit level, and growth of GDP, as well as plant-level productivity, energy prices, and materials prices. Column (2) includes output prices, and column (2) includes a measure of demand shocks estimated using column (2) in Table 4.

Table 7: Effect of Reforms on Exit Probability

Regressor	Main Effects (1)	Trade Reform Interactions (2)	Other Reform Interactions (3)
Lagged Productivity	-0.0078	0.0312	-0.0736
	(0.0036)	(0.0143)	(0.0342)
Lagged Energy Prices	0.0025	0.026	-0.0494
	(0.0011)	(0.0121)	(0.023)
Lagged Material Prices	0.016	0.0717	-0.1018
	(0.0075)	(0.0334)	(0.0474)
Lagged Demand Shocks	-0.0356	-0.0157	0.063
	(0.0166)	(0.0073)	(0.0293)
Trade Reform	0.1723	-	-
	(0.0802)		
Other Reforms	-0.5532	-	-
	(0.2573)		
Sector effects		YES	
GDP growth		YES	
Likelihood Ratio		1,780.9 (46 DF)	
N		57,515	

Notes: Standard errors in parentheses. This table reports marginal effects from Probit estimations of the probability of exit, where exit is 1 for plant i in year t if the plant produced in year t but not in year t+1. The effect of each determinant is allowed to vary with the level of trade reform and reforms other than trade. All columns correspond to the same regression, which includes sector effects at the three-digit level and GDP growth. Column (1) reports the individual effect of each regressor, Column (2) the effects of interactions with the Trade Reform Index, and Column (3) the effects of interactions with an index of reforms other than trade.

Table 8: Aggregate Productivity Decompositions for Different Samples

	Overall Sample			Balanced panel			Three-year continuers		
Year	Weighted (1)	Simple Average (2)	Cross-term (3)	Weighted (4)	Simple Average (5)	Cross-term (6)	Weighted (7)	Simple Average (8)	Cross-term (9)
1982	1.34	1.01	0.33	1.39	1.12	0.27	-	-	-
1983	1.35	0.97	0.38	1.38	1.08	0.31	1.36	0.99	0.37
1984	1.31	0.98	0.33	1.34	1.09	0.26	1.32	1.02	0.30
1985	1.38	1.06	0.33	1.42	1.13	0.29	1.38	1.07	0.32
1986	1.39	1.11	0.28	1.41	1.19	0.22	1.39	1.12	0.27
1987	1.42	1.13	0.29	1.42	1.18	0.24	1.41	1.13	0.28
1988	1.48	1.19	0.29	1.45	1.23	0.22	1.47	1.19	0.28
1989	1.46	1.17	0.29	1.45	1.21	0.24	1.45	1.17	0.27
1990	1.51	1.16	0.35	1.49	1.20	0.29	1.51	1.18	0.33
1991	1.54	1.17	0.36	1.54	1.21	0.33	1.53	1.17	0.37
1992	1.52	1.11	0.41	1.47	1.16	0.31	1.50	1.14	0.36
1993	1.48	1.11	0.38	1.46	1.13	0.33	1.48	1.12	0.36
1994	1.53	1.09	0.44	1.48	1.10	0.38	1.52	1.09	0.43
1995	1.52	1.02	0.50	1.48	1.07	0.40	1.52	1.05	0.47
1996	1.59	1.01	0.58	1.49	1.06	0.43	1.58	1.06	0.52
1997	1.60	1.07	0.53	1.52	1.06	0.46	1.60	1.09	0.51
1998	1.64	1.10	0.54	1.51	1.05	0.46	-	-	-

Notes: All figures are simple means of 3-digit sector level statistics. Columns (1), (4) and (7) show aggregate TFP, calculated as the weighted mean of TFP, where the weight for each plant is its share in corresponding three-digit level sector output. Columns (2), (5) and (8) show the contribution to aggregate productivity of average TFP. Columns (3), (6) and (9) show the contribution of the cross-sectional correlation between plant-level market share and TFP.